A Pavement Management Program for the Town of Wenham

February 1986

PAVEMENT MANAGEMENT PROGRAM

For The

TOWN OF WENHAM

February, 1986

ACKNOWLEDGEMENTS

This report is based on the findings of Nathan Wiseblood, PE and his study entitled: Preliminary Engineering Study of Bituminous Pavements in Wenham, Massachusetts. MAPC is grateful to the following individuals:

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I. SUMMARY

MAPC hired Nathan Wiseblood, P.E., to assist in the development of this pavement management program for the Town of Wenham. Wiseblood performed the roadway pavement condition inspection, developed the resulting 15 year program and provided general guidance to the MAPC staff. The inspection categorized pavement condition into six groupings, established the pavement life and the level of traffic. This information was then summarized into the 15 year program which recommends the resurfacing or rehabilitation of each road and includes cost estimates.

The program estimates that it will cost about $3.5 million to bring the 33.84 miles of Wenham's roads up to good condition within the next fifteen years; that is an average of $240,000 per year. The program recommends that a major portion of this work should be accomplished before the fifth year.

The study concludes that the survey of pavement conditions and pavement life should be periodically updated, especially after a year in which appropriations are not made at the level recommended, requiring that projects be moved to a later year.

Early in the study is recommended that Walnut, Topsfield and Grapevine roads be reconstructed as soon as possible. The Town Meeting has already funded this work.

II. PURPOSE OF STUDY

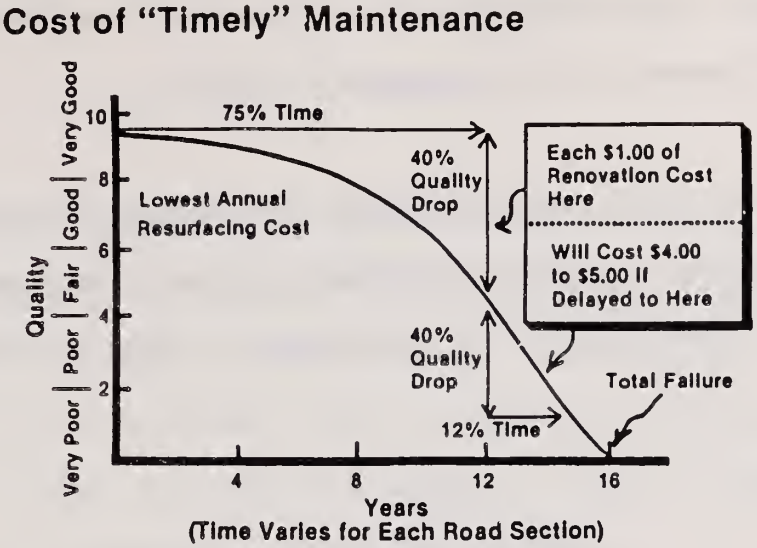
With local funds in short supply in this period of Proposition 2 1/2, local governments may find it easier to reduce highway maintenance funds than funds needed for other strategic services such as schools, police and fire. As roadway conditions worsen, communities are faced with the difficulties of determining their maintenance needs, and assessing costs and benefits in order to prioritize projects. This process is now recognized as a significant component of public works administration and is generally referred to as pavement management.

For several reasons many communities have not developed or implemented pavement management programs. There is an abundance of literature on this subject, but the measurement of pavement condition is often prescribed in a way which requires expensive data collection. Even beyond that step, there are many factors which are difficult to quantify, including the causes of pavement deterioration, the costs of deferring maintenance work, and the institutional elements of prioritizing. Clearly, a policy of timely maintenance reduces annual costs and increases the interval between roadway treatments. To the community with restricted resources however, a complex procedure for planning road maintenance has not been attractive.

Deferring maintenance will escalate the maintenance budget in the long term. As repair work is delayed, damage becomes more extensive. If a road that needs resurfacing is allowed to deteriorate to the point where reconstruction is necessary, the costs may be as much as four to five times greater (see Figure 1).

Figure 1

Consequences of Deferred Maintenance



Source: The Hole Story, APWA, 1983.

Furthermore, road user costs are substantially higher on poorly maintained roads. Through a national data base, it has been estimated that in 1984 the average motorist paid an extra $185 in operating costs, due to excessive wear and damage to vehicles on rough roads.* It appears that a well planned pavement management program will yield benefits far beyond the pavement maintenance costs.

Addressing maintenance needs by short-term response to citizen complaints and safety hazards, and fixing the worst problems without a defined policy of prioritization is inadequate. With timely maintenance schedules, a community can achieve substantial monetary savings.

The MAPC assisted the Town of Wenham in establishing a pavement program for the highway system. As part of the project, the Superintendent of Streets indicated that three roads (Walnut, Topsfield and Grapevine roads) needed immediate attention and requested that the first phase of this project should assess their maintenance needs before the May 1985 town

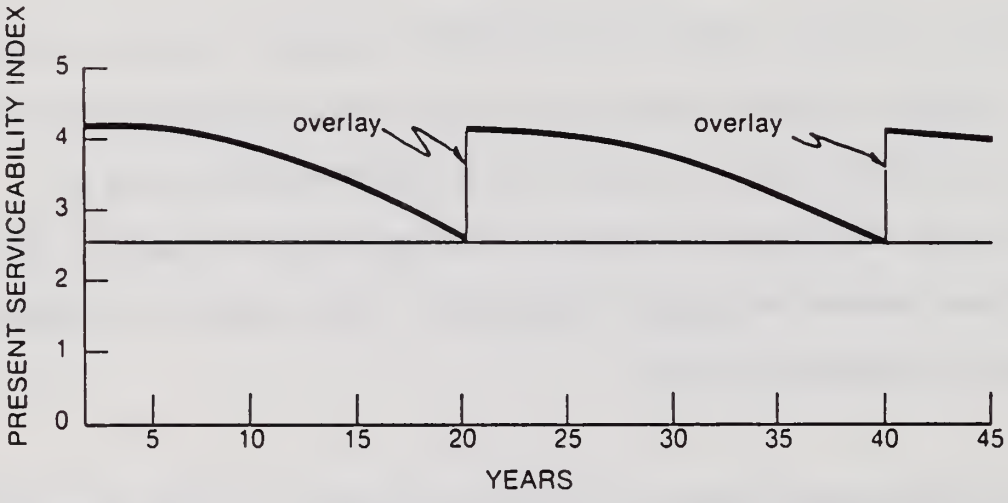
* Better Roads, Editorial Viewpoint, February 1985.

meeting. These roads appeared dangerous because of the fast moving traffic, poor grades and many pavement failures.

The goal of this study was to recommend improvements for these three roads, and develop a pavement management program to keep pavement condition on a track similar to that shown in Figure 2. Ideally, as shown

Figure 2

Idealized Rehabilitation Cycle



Source: Alternatives in Pavement Maintenance, Rehabilitation and Reconstruction, The Asphalt Institute, Info. Series No. 178 (IS-178), May 1981.

by this graph, the pavement receives routine maintenance until it reaches a point where accelerated deterioration is stopped by bringing the pavement back to its original condition such as with an overlay. If this process is followed, then reconstruction is rarely required and the cost of overlays is minimized.

III. STUDY METHODOLOGY

As mentioned above, the first phase of this study dealt with the critical need for improvements for three roads: Walnut, Topsfield, and Grapevine. This phase included field work to assess pavement conditions and recommendations for work in the near future including an estimate of cost. The result of Phase I, presented to Wenham on April 1, 1985, was a report to the Town of Wenham for use in budgeting funds.

This second phase of the study expands the survey to include the entire road system and then establishes priorities and a program for budgeting and implementation.

A. Resources

Programming of pavement maintenance is a complex procedure and there are many options which must be suited to both technical methods and local needs. Therefore, MAPC utilized both outside professional services and a Technical Review Committee.

The Committee reviewed the products of each facet of the study, adding both local perspective and professional judgement to the selection of methods and programming of priorities.

B. Data Collection

Pavement management programming requires information on a number of road characteristics. Surveys were conducted of pavement condition, accidents, and maintenance history. The data collected is described below with respect to format, source, etc. Analysis of the data is described in Chapter IV:

Pavement Survey - The survey of pavement condition was conducted by Nathan Wiseblood, P.E. with the assistance of Peter Burnham, Superintendent of Streets. The field sheet used for the pavement survey is included here as Figure 3. This form requires information on pavement structure and condition, grades, drainage, level of traffic, traffic control, and maintenance history. Visual observation of each road segment provided much of the required data on pavement condition, traffic, drainage, and traffic control. Type and thickness of pavement and base were measured where the pavement edge was exposed, and where potholes or other conditions provided the opportunity. Where necessary, core samples were taken and analyzed to obtain such data.

Figure 3

Field Sheet for Pavement Condition Survey

FIELD SHEET TOWN or City: _____

Streets	Ave. Width	Length Miles	Traffic Class.	Condition Rating	Last Maint.

Present pave: _____ Thickness: _____

Recommended speed limit: _____ Safety: _____

Grades & Contours: _____

Failures: _____

Base & subgrade: _____

No. of catch basins: _____ New catch basins required: _____

Bridges & culverts: _____

Water tables: _____

Rehabilitation ft: _____ Resurfacing ft: _____

Life of pavement, Resurfacing: _____ Rehabilitation: _____

Wetlands, ft. _____ Type of area: _____

Guard rails, ft: Present: _____ Required: _____

Traffic lines: _____

Berms: _____

Riding quality: _____

Remarks: _____

Source: Nathan Wiseblood, P.E., Hopkinton, MA.

Accidents - Accident data for the Town of Wenham was available from the MDPW for the years 1979, 1980, and 1983. The accident data included the pavement conditions. The categories which described road conditions were "no defects; holes; ruts or bumps, foreign matter on surface; defective shoulder, road under construction, other, and not specified". Also, summaries of accident reports were obtained from the Wenham Police Department for the years 1981-1984. Both sources include information on date, location, time of day, number of vehicles involved, collision type (angle, rear-end, head-on, other), severity of the accident (fatality, personal injury, or property damage only) and road surface condition (dry, wet, snowy, icy). The analysis of accident data is reported in Chapter IV.

Maintenance History - Keeping records on the maintenance history of the highway system with periodic updates is an important element of a pavement management program. Information on pavement age, design, and the history of repairs and treatments can be helpful in choosing the best maintenance strategy. Unfortunately, the Town of Wenham does not have a record of maintenance activities by road. It is suggested that the Town of Wenham begin documenting its maintenance activities.

C. Procedures

A review of available procedures and methods for measuring pavement condition resulted in a presentation to the committee of a procedural guide. The guide documented types of pavement failure, and provided an alphabetic pavement evaluation system.

A survey of pavement conditions included fourteen types of pavement failure. These are a subset of the many pavement distress types found in the literature and they correspond particularly to those found in the northeastern United States. Descriptions and definitions of these selected types of pavement failure are included in Table 1.

The survey of pavement failure was transferred into an assessment of pavement condition using a scale from A to F (best to worst). The pavement condition of each segment of road was classified according to the definitions found in Table 2.

Project Programming In the development of a program, Wiseblood identified, for each street segment, the type of maintenance treatment required and best time to perform the work. In recommending the timing for such work, the implications of deferring maintenance were the primary concern. In some instances, immediate work is needed to avoid more expensive repairs at a later time. In other cases, the pavement was in good enough condition that it did not require immediate attention, and in still other instances, pavement condition is at the point of requiring major work, but that work can be scheduled for another year without significant loss of safety or rideability.

Table 1

PAVEMENT FAILURE DEFINITIONS

Fatigue Cracks	- Old age - 15+ years.
Transverse Cracks	- Cracks across the road, caused by settlement of base, heavy loads, and age.
Longitudinal Cracks	- Cracks alond the road in the direction of travel, caused by age, loads, poor bond between paving strips.
Alligator Cracks	- Interconnecting longitudinal and transverse cracks. Predecessor of the pothole. Caused by base failure, age, overloading, substandard materials, water infiltration, low stability.
Shrinkage Cracks	- Transverse cracks caused by seasonal elongation and contraction of the pavement. Will occur within a few years of any bituminous pavement of low stability.
Rutting or Chanellizing	- Depressions or ruts in the pavement surface along wheel tracks. Indicates base failure and/or thin pavement and low stability.
Corrugations	- Transverse "ripples" in the pavement. Caused by base failure, or poor compaction.
Raveling	- Sections of the top pavement layer loose and missing from binder. Indicates poor construction, improper bond between pavement layers, low bitumen, poor adhesion, incorrect mix design, poor compaction, low stability.
Shoving or Pushing	- Heaves, depressions and bumps caused by continued hard braking action of vehicles deforming the pavement. Usually at intersections, due to high and soft bitumen content and low stability.
Pot Holes	- Failed pavement caused by lack of maintenance. Water infiltrates through cracks, washes away fine material in base, freezes and thaws, causing pavement disintegration, also poor adhesion, low bitumen and low stability.
Excess Asphalt	- Slippery, shiny black surface with no stone showing. Indicates poor original pavement quality.
Polished Aggregate	- Excessive tire wear to pavement surface, wears away asphalt, exposing and polishing the stone content.
Deficient Drainage	- Lack of catch basin and piping system; puddles on or alongside pavement; wet shoulders. Major factor in pavement damage.
Overall Riding Quality	- Smoothness of ride at posted speed limit.
Reflection Cracking	- New failures in recent pavement exactly over underlying old failures.
Map Cracking	- A series of eratic fine surface cracks in no definate pattern, varing from 1/16 to 1/4 inch wide (odd shaped and crooked lines resulting from surface pavement weakness).

Source: Massachusetts Department of Public Works

Table 2

Classification of Pavement Conditions

A	Excellent Condition: 10 or more years, with light maintenance.
B	Good Condition: With 5 or more years under normal maintenance.
C	Fair: Deteriorating rapidly - rehabilitation within 4 to 5 years. Recommend resurfacing within 2 to 3 years.
D	Poor Condition: New construction can be delayed for 3 to 4 years under heavy maintenance. Save money by resurfacing within 1 to 2 years.
E	Very Poor Condition: Nearly total failure. Rehabilitation can be delayed for 2 to 3 years. Combination of resurfacing and rehabilitation, if money's available, within 1 to 2 years.
F	Complete Failure: Roadways can be dangerous. Continuous patchwork necessary to make these roadways serviceable. Delays will be costly both to the Town and car owners using these roads. Rehabilitation should begin at once.

Source: Nathan Wiseblood, P.E. Hopkinton, MA.

IV. ANALYSIS

This chapter presents the findings of the road inventory, pavement condition survey, and accident analysis.

A. Road Network

Wenham is a small community. Its 8.3 square miles are traversed by 33.84 miles of roads of which 32.24 miles are paved. Table 3 is an inventory of these roads and includes the street length and average width. Route 128 is the only limited access road and passes through one corner. Route 1A, which passes north to south through the middle, is the only other road maintained entirely by MDPW. Route 97, the only other numbered route, is maintained by the Town of Wenham.

Each town and city in the state receives what is commonly referred to as "Chapter 90 Funds" which are available for reconstruction of roads on the State Aid Primary System shown on Table 3. According to Burnham, Superintendent of Streets, Wenham's appropriation for 1986 is $316,399. Federal Urban System funds are also available to communities, but they are generally used for capacity and safety improvements and not for typical maintenance projects except where included as part of a capacity/safety project.

The road inventory conducted by Wiseblood included a classification by heavy, medium, and light traffic. According to Wiseblood, heavy traffic occurs when a large percentage of trucks pass over the road, medium

Table 3
INVENTORY OF WENHAM ROAD NETWORK
WENHAM

Roadway Name	Length (miles)	Average Width (feet)	State Aid Primary System
Arbor Street	0.62	27	
Ayer Estate Farm Road*	**	**	X
Batchelder Park Road	0.11	14	X
Beverly and Salem Water Road	0.17	10	X
Birch Road	0.13	30	X
Boulder Lane (unpaved)	0.32	18	X
Bruce Lane	0.16	30	X
Bryant* (unpaved)	0.20	**	X
Beverly Street*	0.45	20	
Burley Street	0.45	24	
Burnham Road	0.61	24	X
Cedar Street	0.91	22	
Cemetery*	0.50	15	X
Cherry Street	1.52	28	
Chestnut Street	0.04	18	X
Conrad Circle	0.28	23	X
Daniels Road	0.47	30	X
Dodge Road	0.72	28	
Eaton Road	0.20	30	X
Eddel Avenue	0.20	25	X
Ellis Avenue	0.12	19	X
Enon Road	0.19	24	X
Essex Street	0.41	25	X
Fairview Avenue	0.04	24	
Fire Station / Post Office Lot*	0.14	24	X
Fiske Road	0.29	28	X
Foster Street	0.28	24	X
Friend Court	2.22	36	X
Garage / Highway Department*	0.35	**	X
Grapevine Road	3.37	51	
Great Pond Road	0.38	24	X
Grover Street	0.04	18	
Hickory Lane*	0.20	**	X
Hilltop Drive	0.70	25	X
Horseshoe Lane (unpaved)	0.35	18	X
Howard Street	0.15	20	X
Hull Street	0.38	25	
Juniper Street	2.20	26	X
Kimball Avenue	0.37	30	X
Knoll Road	0.02	18	X

* Roadway included in consultant survey but not in MDPW Road Inventory File.
** Information not included in either consultant survey or MDPW Road Inventory.

Table 3 - Cont

INVENTORY OF WENHAM ROAD NETWORK

WENHAM

Roadway Name	Length (miles)	Average Width (feet)	State Aid Primary System
Lake Avenue	0.21	28	X
Lake Street* (unpaved)	0.16	18	X
Larch Lane	0.18	25	
Laurel Drive	0.15	18	X
Leigh Road (unpaved)	0.02	14	X
Library Parking Lot Rd.*	0.34	24	X
Linden Street	0.07	27	X
Lois Street	0.04	20	X
Longfellow Road (unpaved)	0.17	10	X
Main Drive	0.15	26	X
Main Street	1.76	38	X
Maple Street	0.91	24	
Mayflower Road (partially paved)	0.32	36	X
Meridian Road	0.20	27	X
Monument Street	0.41	30	
Morgan Street	0.36	26	X
Route 1A*	2.80	**	X
Oak Street* (unpaved)	0.05	10	X
Old Rubbly Road*	0.50	20	X
Patch Avenue*	0.16	12	X
Patti Lane	0.10	30	X
Perkins Street	0.29	20	X
Pleasant Street	0.88	20	X
Porter Street	0.39	20	X
Pump House Road	0.14	15	X
Puritan Road	0.49	24	X
Regwill Avenue	0.12	22	X
Rubbly Road	0.28	26	
School Street	0.18	22	X
South Street (unpaved)	0.04	10	X
Speakers Lane	0.08	16	X
Stanton Street	0.10	18	X
Topsfield Road	2.21	26	
Unnamed Road	0.11	**	X
Walnut Lane	0.11	18	X
Walnut Road	0.88	26	
Williams - Fairfield Drive	1.28	24	X
Woodside Lane (unpaved)	0.43	14	X
Yankee Division Highway (Rte 128)	0.87	24	X
Total	38.20		
Ave.	0.49	21.12	

* Roadway included in consultant survey but not in MDPW Road Inventory File.

** Information not included in either consultant survey or MDPW Road Inventory.

traffic occurs in residential areas that are congested and light traffic generally occurs when houses are far apart. Obviously, heavy, medium and light traffic designations will differ depending on the area and the person doing the survey.It is generally recognized that roads carrying heavy traffic have a tendency to deteriorate faster and may require more frequent repair. Although this classification is based on casual observations, it is important to note that there is a large percentage of heavily travelled roads. According to Wiseblood's subjective evaluation, approximately 14.33 miles are heavily travelled.

B. Accident Analysis

High concentrations of accidents, caused by physical conditions such as road alinements, traffic controls or pavement conditions should be given high priority in the development of a program. However, the analysis of accident data did not reveal such locations.

Accident records from the Wenham Police Department for 1984 are summarized in Table 4. Although the number of accidents per mile of roadway varies from 2.3 for Pleasant Street to 20.5 for Route 1A, the major factor in that difference appears to be traffic volume. Accidents are generally compared on a "per million vehicle miles", but in this study the necessary data to make that calculation was not available.

Accident records from the files of MDPW offer a comparison of accident

Table 4
1984 Accidents by Street

Road	Number of Accidents	Length of Road	Accident per Mile	Functional Classification	Traffic* Level
Rt. 1A/ Main St.	36	1.76	20.5	Primary	High
Topsfield Rd	16	2.20	19.5	Urban	Medium
Larch Row	14	2.02	14.3	Urban	High
Grapevine Rd.	14	2.76	11.8	Urban	Med-High
Cherry St.	10	1.52	9.7	Urban	Med-High
Monument St.	8	.41	7.7	Urban	High
Maple St.	7	.91	7.3	Urban	Med-High
Walnut St.	6	.88	6.9	Urban	Medium
Arbor St.	6	.62	6.8	Urban	High
Rubbly Rd.	4	.28	6.6	Urban	Low-Med.
Cedar St.	3	.91	5.1	Urban	Medium
Burley St.	2	.17	3.4	Urban	Low
Dodges Row	2	.72	2.8	Urban	Med-High
Pleasant St.	2	.88	2.3	Local	High
Average	9.28	1.14	8.91		

Source: Wenham Police Department
*Traffic level was determined by observation by Wiseblood

rates with road conditions, although this data is for 1979, 1980 and 1983. This analysis is presented in Table 5. Note that on a town-wide basis, the percentage of accident reports in which defective road conditions were cited is very small. Of the 12 cases where defects were noted, three occurred on Route 128, three on Topsfield Road, and three on Main Street.

C. Pavement Conditions

The field survey included two separate ratings of pavement condition on each road in addition to detailed remarks concerning specific deficiencies. The first is the alphabetic pavement condition rating from A (best) to F (worst) as described previously. The second is the rating of the life of the pavement (the number of years of service expected before pavement failure). A summary of the field survey sheets resulted in the following:

- 5.61 miles are rated "F " and can be kept serviceable with expensive maintenance for 2 to 3 years and will then require reconstruction.

- No miles are rated "E".

- 15.73 miles are rated "D" and rehabilitation can be held off for 3 to 4 years with costly maintenance.

- 2.13 miles are rated "C" and with normal maintenance can wait 4 to 5 years before rehabilitation.

- 8.61 miles are rated "B" and "A" and can be rehabilitated

Table 5

Accidents by Road Condition

Year	No Defect	Holes, Ruts, Bumps	Defective Shoulders	Other or Not Specified	Total
	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
1979	116 (88.5)	1 (0.8)[a]	1 (0.8)[a]	13 (9.9)	131 (100)
1980	106 (86.9)	1 (0.8)[b]	0 (0.0)	15 (12.3)	122 (100)
1983	61 (70.9)	3 (3.5)[a,b,c,]	6 (7.0)[d]	16 (18.6)	86 (100)
Total	283 (83.4)	5 (1.5)	7 (2.1)	44 (13.0)	339 (100)

Source: Mass. DPW

Traffic Engineering Section

a = Route 128

b = Topsfield Rd

c = Burnt Swamp Rd (not on pavement inventory)

d = 1 on Cherry St., 3 on Main St., 1 on Larch Row, 1 on Topsfield Rd.

in 5 to 15 years with regular light to normal maintenance.

A summary of the pavement condition in comparison to the observed level of traffic volume shows the following:

- o light traffic roads have the best pavement condition rating eg B+
- o medium traffic roads have a rating of C.
- o heavy traffic roads have the worst rating eg D.

A sample field survey sheet fouind in the Appendix, indicates the type and extent of cracking, patching, etc. on each road as well as deficiencies in drainage, safety and so forth.

V. PROGRAM DEVELOPMENT

A number of recommendations are made concerning the implementation of this pavement management program. The program recommended by Wiseblood covers a 15 year period. Wiseblood provides estimates of the cost for maintenance and a recommended schedule. The program should be periodically updated and refined, especially in those years when the recommended work is not achieved. This program is the starting point for a working pavement management program.

A. Immediate Needs

Early detection and repair of minor defects are most important in an efficient pavement management program. As noted earlier, funding has been appropriated and progress made on resurfacing Walnut Road, crack sealing Topsfield Road (with resurfacing planned for early spring 1986), and partial resurfacing of Grapevine Road.

B. 15 Year Program

The most costly element of the program is the first four years, due to the present condition of the town roads. From a town funding point of view, it would be ideal to spread costs out evenly over the 15 year period with each year costing about the same amount. Under a well run program, that had been in operation for at least one cycle of fifteen years this

would be possible, but previously under-funded maintenance now requires major investments. Table 6 is the estimated 15 year pavement management program for Wenham with an estimated total cost of approximately $3.5 million. This estimate includes inflation based on an average of 10 percent per year.

The third year of the program developed by Wiseblood suggests an expenditure of $1.1 million. If the town decides to undertake that amount of work more than likely bonding will be required. If this level of work is not accomplished, there will be continued deterioration and increased user costs. Such circumstances will require a re-evaluation of the road network, re-inventorying pavement condition, establishing new priorities and making adjustments to the program. In any event the highway superintendent should update the inventory and program every couple of years. As noted earlier, the type and timing of maintenance actions are estimates and require monitoring and updates.

Following are the conditions that were applied by Wiseblood in the development of the program.

- Light maintenance (grading) to gravel roads and pave within 5 years.

- Perform light maintenance on good paved roads; most should hold for 7 to 10 years; then resurface with 1 1/2 inches of heavy duty pavement.

Table 6

Estimated Pavement Costs Per Year

Traffic Type	Year 1	2	3	4	5	6 to 15	Total
Heavy	$22,603	$85,653	$766,122	$256,960	$79,947	$454,440	$1,660,725
Medium	195,280	85,675	197,250	133,493	N/A	241,085	852,783
Light	61,250	79,176	147,199	137,438	112,042	177,027	714,082
Inflation	N/A	11,876	44,144	61,847	67,225	177,027	362,119
Total	$279,133	$262,380	$1,154,665	$ 589,738	$254,214	$1,049,579	$3,589,709

- Most prime and chip sealing is scheduled for 3 to 5 years.

- Costs include catch basins where necessary.

- Patched roads can hold for 1 to 3 years before heavy maintenance is required. Use 8 to 10 inches of recycled pavement as a stabilized base for the patches.

- Locations having thin pavement and poor shoulders have been identified; major maintenance (ie rehabilitation) should take place in 3 to 4 years.

- Thin road surfaces (an inch or less) should be reconstructed using 5 to 7 inches of bituminous stabilized base including 1 1/2 inches recycled heavy duty pavement.

- Sidewalks, in designated locations, should be added within 2 to 3 years.

- Poorly compacted roads (less than 98% compacted) have been scheduled for improvement in 4 to 5 years.

Detailed recommendations for resurfacing and rehabilitation are summarized in Table 7 and a sample survey sheet filled out during the inventory is included in the Appendix. The original survey sheets can be obtained from Mr. Burnham. The priority setting method used by Wiseblood is generally based on pavement life and the relative amount of traffic. That means shorter pavement life and high traffic volumes were given higher priority.

The substructure profile and photographs of the existing pavement condition are also helpful. Records of pavement condition, maintenance and costs are essential to carrying out a useful pavement management program.

A backlog of road maintenance needs coupled with uncertainty as to which projects to do first is an issue that is not easily met without careful planning and proper adherence to a program. The consequences of not following this type program but rather deferring maintenance were discussed earlier. At the other extreme a successful program should not end abruptly when the 15 year period is terminated. It is suggested that Wenham plan for the future, both within and beyond the 15 year program, using this report as a tool. In planning for the future, Wenham will be able to make adjustments which reflect changes over time such as accelerated deterioration, increased maintenance demands, and traffic growth. MAPC is developing a new manual on Pavement Management for Communities. This manual will be helpful in addressing issues such as pavement evaluation, project prioritization and budgeting.

Table 7

Consultant Survey of Roads in Wenham

Road	Level of Traffic [1]	Pavement Conditions [2]	Recommended Action Rehabilitation	Resurfacing	Recommended Year of Action
Burley St. A [3]	M	F	X		1
Friend Court A	L	C-F [4]	X		1
Hill Top Dr.	M	E-F	X		1
Linden St	M	E-F	X		1
Rubbly Rd.	M-H	B-F	400 [6]	2000	1
Topsfield Rd. A	H	C-F			1
Walnut St.	M	F	X		1
Boulder Lane	L	D-F		X	2
Burnham Rd.	M	E-F	X		2
Dodges Row	M-H	n.a.	2150	1652	2
Juniper St.	L	C-F	240	1133	2
Knoll Rd.	L	D-F	X	X [5]	2
Leigh Rd.	L	F		X	2
Longfellow Rd.	L	F	X		2
Main Dr.	M	E-F	X		2
Oak St.	L	F		X	2
School St.	L	C-F	700	250	2
Bryant	L	F		X	3
Cherry St.	M-H	B-F	X		3
Fairview Ave.	L	D-E	X		3
Friend Court B	L	C-F		X	3
Grapevine Rd.	M-H	C-E		X	3
Lake St.	M	D-F	X		3
No. 1A	H	B-D	X		3
Old Rubbly Rd.	L	E-F			3
Pleasant A	M	B-F		X	3
Puritan Rd.	L	D-F	X		3
South St.	L	F	X		3
Topsfield Rd. B	H	C-F	X	X	3
Williams Fairfield Dr.	M	B-E	1500	X	3
Woodside Lane	L	F	X		3
Bachelder Park	L	B-F	X		4
Burley St. B	M	C-D		X	4
Cedar St.	M	C-E			4
Chestnut St.	L	D-F	X		4
Enon Rd.	L	C-F	X		4
Fire Sta/P.O. Lot	M	C-F	X	X	4
Fiske Rd.	L	D-F	X		4

1) L-Low, M-Medium, H-High
2) A-Best, F-Worst
3) Suffix indicates road segment used by Wiseblood. Limits of segment are noted on survey form.
4) Pavement condition varies within segment of road.
5) Where both actions are recommended, Wiseblood suggests that more detailed analysis be performed by the Highway Superintendent.
6) Feet

Table 7 - Cont

Consultant Survey of Roads in Wenham

Road	Level of Traffic [1]	Pavement Conditions [2]	Recommended Action Rehabilitation	Resurfacing	Recommended Year of Action
Great Pond Rd.	L	C-F [4]	X		4
Larch Row	H	B-F	9000 [6]	2600	4
Laurel Dr.	L	n.a.	X		4
Library Parking Lot	L	C-F	X	X [5]	4
Mayflower Dr.	L	n.a.	X		4
Porter St.	M	C-E		X	4
Conrad Circle	L	D-E	X		5
Ellis Ave	L	C-D		X	5
Foster St.	L	B-D		X	5
Kimball Ave.	L	D-F	X	X	5
Meridian Rd.	L	C-D	X		5
Monument St.	H	B-D	X	X	5
Morgan St.	L	D-F	X	X	5
Pleasant B [3]	M	B-F	X		5
Arbor Rd.	H	B-C		X	6 - 15
Birch Rd.	L	B-C		X	6 - 15
Bruce Lane	L	B-C		X	6 - 15
Cemetary	M	B-D		X	6 - 15
Daniels Rd.	L-M	B-C		X	6 - 15
Eaton Rd.	L	C-D		X	6 - 15
Eddel Rd.	L	B-C		X	6 - 15
Essex St.	H	A-C		X	6 - 15
Friend Court C	L	C-F		X	6 - 15
Garage/Hwy Dept	H	B-C		X	6 - 15
Grover St.	M	B-D		X	6 - 15
Horseshoe Lane	L	n.a.		X	6 - 15
Howard St.	L	B-D	X	X	6 - 15
Hull St.	M	B-C	X	X	6 - 15
Lake Ave.	L	B-E	X		6 - 15
Larch Lane	L	B-C		X	6 - 15
Maple St.	M-H	B-C	X	X	6 - 15
Patti Lane	L	B-D		X	6 - 15
Perkins St.	M	B-E		X	6 - 15
Pumping Station	L	B-C	X		6 - 15
Regwill Ave.	L	C-D	X	X	6 - 15
Speakers Lane	L	B		X	6 - 15
Stanton St.	L	B-C		X	6 - 15
Walnut Lane	L	C-D	X		6 - 15

1) L-Low, M-Medium, H-High
2) A-Best, F-Worst
3) Suffix indicates road segment used by Wiseblood. Limits of segment are noted on survey form.
4) Pavement condition varies within segment of road.
5) Where both actions are recommended, Wiseblood suggests that more detailed analysis be performed by the Highway Superintendent.
6) Feet

V. CONCLUSIONS

A. Quality Control

Forecasting maintenance strategies beyond five years is difficult and, therefore, Wiseblood provides a broad time schedule (see table 7) for which resurfacing and rehabilitation should be accomplished. It is strongly suggested that the roads which require remedial action after 5 years be re-programmed into a more definite plan. Table 3 provides length in miles and average width in feet for Wenham's road network. Estimated pavement costs per year suggested by Wiseblood are shown in Table 6. Furthermore, Table 7 provides a list of roads with suggested improvements and corresponding year of action. Wiseblood rated pavement condition, mentioned earlier in this report, on a scale of A (best) to F (worst). In situations where the road consisted of two or three different pavement condition segments, Wiseblood segmented the street on the survey forms and added A,B,C after the street name as shown on Table 7. In some situations, Wiseblood recommends either resurfacing or rehabilitation. Good engineering judgement should be used in determining the proper remedial action.

Core samples should be taken whenever a base has failed. It is important that the road base be constructed properly in order to establish a quality road. Information on substructure also provides a means to predict the life of the pavement.

Drainage: A surface that drains adequately and a base which allows for some upward percolation of subsurface water to replace moisture lost by evaporation are essential in maximizing road life. A surface that is not adequately drained will experience the formation of potholes and cracks due to thermal expansion and contraction. Edge failure due to shoulder erosion is also related to drainage. Early detection and repair of minor defects is the most important phase of maintenance work.

B. Updating the Program

Communities are faced with the question of how to adjust their program when maintenance is deferred. Tight budgets and a small staff are the two major causes of deferred maintenance. In addition, a misunderstanding of when to perform high maintenance levels of work and minimum maintenance levels of work make decisions difficult. Consideration should be given to presenting a "reasonable" request to the finance committee and if the Superintendent feels that the appropriation will be difficult to obtain then he should reconsider pavement condition, traffic levels, and expected life in revising the 15-year program recommended by Wiseblood. Good judgement is required in this decision-making process. Expenditures and maintenance activities of previous years, if possible, should be closely compared to changes in pavement condition. Adjustments should be made to reflect changes over time such as inflation. Finally, the road inventory must be expanded to reflect these adjustments made by the Superintendent.

Records are an essential element to pavement maintenance. Looking at previous records will show progress in the program as well as changes in pavement conditions. By keeping inventories current, future maintenance can be addressed more promptly. Data on construction and maintenance of a road is beneficial in establishing future maintenance requirements.

Wiseblood used two general categories of road improvements in his survey. The first is rehabilitation and the second is resurfacing. Costs for these remedial actions were related to the amount of traffic on the road. Treatment and, therefore, unit costs varied depending on these factors.

VII. APPENDIX

Included in the Appendix is a sample field sheet (Exhibit 1) of a survey conducted by Wiseblood and also his unit cost estimates per mile for resurfacing and rehabilitation of roads with light, medium and heavy traffic (Exhibits 2 through 7) taken from a report supplied by Wiseblood, P.E. entitled: Preliminary Study of Bituminous Pavements in Wenham, Massachusetts. A copy of the original report can be obtained from Burnham, Superintendent of Streets.

The report given to Burnham includes a letter to Stephen H. Rose providing a summary of failures, evaluation of test results and priorities of roads for rehabilitation and resurfacing. Pavement reconstruction costs and their corresponding repairs by heavy, medium and light duty roads are included. Roads are rated according to heavy, medium and light traffic. A 15 year pavement management program is suggested. Technical specifications are provided as well as laboratory test results. A street map for the town is included indicating that first priority be given to Grapevine, Topsfield and Walnut roads. Finally, a list of streets with corresponding field sheets describe the surveys conducted by Wiseblood.

Exhibit 1
Sample Field Sheet used by Wiseblood to establish a road inventory for the roads in Wenham.

4-5

FIELD SHEET TOWN or City: Wenham

Streets	Ave. Width	Length Miles	Traffic Class.	Condition Rating	Last Maint.
Conrad Circle	23	.30	Light	D+F	

Present pave: Bit. Conc. I-1 B1"+T1" Thickness: 2"

Recommended speed limit: 25 MPH Safety: Fair

Grades & Contours: Fair to Poor

Failures: Variable - Base - Alligator - Low Stability

Base & subgrade: Good Gravel - Poor Compaction - Silty Sub Grade

No. of catch basins: 13 New catch basins required: ____

Bridges & culverts: ____

Water tables: ____

Rehabilitation ft: .30M Resurfacing ft: ____

Life of pavement, Resurfacing: ____ Rehabilitation: 4 to 5 yrs

Wetlands, ft. ____ Type of area: Residential

Guard rails, ft: Present: 0 Required: ____

Traffic lines: 0

Berms: 0

Riding quality: Fair

Remarks: Low Stability I-1 mix - 1" T 1" B over very good gravel, poorly compacted resulted in many failure, even though under very light traffic - Rehabilitation and heavy duty Bit Concrete can be put off for 4 to 5 years with constant maintenance.

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 2
Unit Cost per mile for resurfacing roads with light traffic.

RESURFACING - LIGHT DUTY

Estimates Per Mile 24' Wide - 2' Shoulders		
(1)	Hot Recycled Bit. Conc. Avg. 1½" thick one course to correct grades @ $2.60/sq. yd.	$ 35,165.00
(2)	Rubberized AC Joint Sealer & Cracks greater than ½" thick estimate 6,000 ft. per mile @ $.33/ft.	1,980.00
(3)	Map cracking estimate 500 sq. yd. @ $.60	300.00
(4)	Shoulders, ½" processed stone @ $.50/sq. yd.	1,173.83
(5)	One Traffic Line @ $.12/ft.	633.60
		$ 39,251.93

Extras - Guesstimates

(6)	Guard Rails - 500 ft. @ $17/ft.	$ 8,500.00	
(7)	Subsurface Drainage Stone 750' @ $5/ft.	3,750.00	
		12,250.00	

Recommend Bid with Extras of $12,250 for a

TOTAL ESTIMATE OF $ 51,501.93

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 3
Unit Cost per mile for resurfacing roads with medium traffic.

RESURFACING - MEDIUM DUTY

Estimates Per Mile 24' Wide - 3' Shoulders

(1)	I-1 Top levelling Avg. 1" thick @ $1.85/sq. yd.		$ 26,048.00
(2)	Hot Recycled Bit. Conc. Avg. 1½" thick @ $2.60/sq. yd.		35,165.00
(3)	Rubberized AC Joint Sealer & Cracks greater than ½" estimate 7,500 ft. @ $.33/ft.		2,475.00
(4)	3 Traffic Lines @ $.08/ft.		1,267.20
(5)	Map cracking, estimate of 1,000 sq. yd. @ $.50/ sq. yd.		500.00
(6)	Shoulders, ½" Processed stone @ .60/sq. yd.		2,112.00
			$ 67,567.20
	Extras Guesstimates		
(7)	Guard Rails -1,000 ft. @ $17/ft.	17,000	
(8)	Subsurface Drainage Stone 1,500' @ $4.00/ft.	6,000	
		23,000	

Recommend Bid go out with simplified Extras of $23,000

for a TOTAL ESTIMATE OF $ 90,567.20

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 4
Unit Cost per mile for resurfacing roads with heavy traffic.

RESURFACING - HEAVY DUTY

Estimates Per Mile — 24' Wide - 4' Shoulders

(1)	I-1 Top Levelling - Avg. 1¼ thick @ $2.16/sq. yd.		$ 30,412.80
(2)	Hot Recycle Cit. Conc. 2" thick @ $3.33/sq. yd.		46,886.40
(3)	Rubberized AC Joint Sealer & Cracks greater than ½" - Estimate 8,000 ft. @ $.33/ft		2,640.00
(4)	3 Traffic Lines @ $.08/ft.		1,267.20
(5)	Map cracking - Est. 1500 sq. yds. @ $.50/yd (Rubberized AC @ .30 gallons/sq. yd.)		750.00
(6)	Shoulders - ½" processed stone @ $.80/sq. yd.		3,754.67
			$ 85,711.07
	Extras Guesstimates		
(7)	Guard Rails - 1,000 ft. @ $17/ft.	17,000	
(8)	Subsurface Drainage Stone 1,500' @ $4.00/ft.	6,000	
		23,000	

Recommend Bid go out with simplified Extras of $23,000

for a TOTAL ESTIMATE OF $ 108,711.07

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 5
Unit Cost per mile for rehabilitation of light traffic roads.

REHABILITATION - LIGHT DUTY

Estimates Per Mile 24' Wide - 2' Shoulders

Base - Same as Heavy Duty except 7" of Mixed Bit.Stabilized Base with 5" compacted Base and excess for 2' shoulders.

(1)	Estimated Cost @ $2.40/sq. yd.	$ 39,424.00
(2)	1¼" of Recycled Hot Heavy Duty Bit. Conc. with 2500# Min. Stability Estimated cost @ $2.35/sq. yd.	33,088.00
(3)	Rubberized AC Joint Sealer @ $.33/ft.	1,742.00
(4)	1 Traffic line @ $.12/ft.	633.60
	Total	$ 74,887.60

Extras - Guesstimate same for all roads and streets.

Guard Rails & Subsurface stone drainage = $23,000

ESTIMATE FOR BID - PER MILE $ 97,887.60

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 6
Unit Cost per mile for rehabilitation of medium traffic roads.

REHABILITATION - MEDIUM DUTY

Estimates Per Mile 24' Wide - 3' Shoulders

Base - Same as Heavy Duty except 9" of Bit. Stabilized Mix with a 6" compacted Base and excess for shoulders.

(1)	Estimated Cost @ $2.70/sq. yd.	$ 47,520.00
(2)	1½" Recycled Heavy Duty Bit. Conc. with 2500# Min. Stability @ $2.60/sq.yd.	35,165.00
(3)	Rubberized AC Joint Sealer @ $.33/ft.	1,742.00
(4)	3 Traffic lines @ $.08/ft.	1,267.20
	Total	$ 85,694.20

Extras - Guesstimate same as Heavy Duty

(5)	Guard Rails - 1,000' @ $17.50/ft	17,000.00
(6)	Sub-grade drainage stone	6,000.00
	Total	$ 23,000.00
	ESTIMATE FOR BID - PER MILE	$ 108,694.20

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.

Exhibit 7
Unit Cost per mile for rehabilitation of heavy traffic roads.

REHABILITATION - HEAVY DUTY

Estimates Per Mile 24' Wide - 4' Shoulders

Base - (Scarify, pulverize, windraw, SS-1 Asphlat Rejuvenation, Mix 12" thick, removal of unsuitable sub-grade - replacing with stone or Bit. Stabilized Base, 98% sub-grade and 8" Base compaction - excess Base for shoulders - Fine grading with ½" processed stone.

(1)	Estimated cost per mile - $3.00/sq. yd.	$ 56,320.00
(2)	2" Recycled Bit. Conc. (Heavy duty) with 2500# Min Stability, estimated @$3.33/sq. yd.	46,886.40
(3)	Rubberized AC Joint Sealer $.33/ft.	1,742.00
(4)	3 Traffic Lines @ $.08/ft.	1,267.20
	Totals	$ 106,215.60

Extras - Guesstimate Per Mile

(5)	Guard Rails - 1,000' @ $17/ft.	17,000.00
(6)	Subsurface drainage "French" or stone - 1500' @ $4/ft.	6,000.00

Note - 12" Drainage pipe 2500' @ $19/ft 47,500

2 Catch basins @ $975 1,950

Subsurface perforated pipe @ $13.50/ft (replaces #6 - 1st class construction 20,100

69,550

Simplified Extras should be 23,000.00

or if surface 12" drainage concrete pipe & catch basins & perforated subsurface = 87,525

Recommend Bids go out with Simplified Extras of $23,000 for Guard Rails and Stone Subsurface drainage for a TOTAL ESTIMATE OF $129,215.60.

Source: Nathan Wiseblood, PE, Preliminary Engineering Study of Bituminous Pavements In Wenham, MA, August 1985.